STRICOM Technology Base: Assessments and Investments Project Report

1. Background.

US Army requirements for advanced modeling and simulation (M&S) capabilities to support training, education, and military operations (TEMO), research, development and acquisition (RDA), and advanced concepts and requirements (ACR) activities are increasing. To meet these requirements, STRICOM has established technology generation and application as a core competency and the responsibility of the Director of Research and Engineering Management. A key component is the STRICOM Technology Base Program, established to identify leap-ahead technologies and facilitate their development in the market place in time to support STRICOM's M&S acquisitions and satisfy Army needs.

There are multiple sources for STRICOM's tech base requirements including: STRICOM's Program Managers (PMs), STRICOM's Long Range Planning (LRP) Process, and selected TRADOC Functional Operational Capabilities (FOC). There are also a variety of research contracts and activities available to develop the needed technological capabilities. These include direct awards for responses to STRICOM's Broad Area Announcement (BAA), Small Business Innovation Grants (SBIR), investment under STRICOM's assigned Science and Technology Objectives, and Advanced Concepts and Technology II activities. STRICOM can also leverage other Government activities including the Defense Modeling and Simulation Office (DMSO), the Defense Advanced Research Project Agency (DARPA), Advanced Concepts and Technology Demonstrations (ACTD). Even so, limited resources require cohesive strategies and procedures to ensure the research activity applied is appropriate to the requirement, redundant assignments are avoided, and other Government R&D activities are leveraged as much as possible.

To assist STRICOM's investment planning for FY98, MITRE conducted an initial assessment of selected M&S technology areas modified from a taxonomy published in a 1993 Electronic Industries Association (EIA) market study of synthetic environment enabling technologies. MITRE conducted assessments in FY 97 for database management, distributed component technologies, intelligent simulation, voice interfaces, sensor processing, networked communications, display technologies, tracking technologies, real time 3D graphics, and real-time 3D sound. Ideally, technology assessments would have been made against well-defined requirements and appropriately derived objective metrics with specified minimums and goals. However, STRICOM's schedule for FY98 investment decisions could not wait for a detailed requirement analysis. So, the FY97 assessment was presented as generic, preliminary, and subject to refinement once STRICOM tech base requirements were established.

2. Purpose of Report

During FY98, MITRE developed methodologies to formulate a tech base investment strategy that

is repeatable, consistent, and relevant to Army needs. It provides for the traceable derivation and prioritization of "Tech Base Requirements" from STRICOM PM Statement(s) of Need and relevant TRADOC FOCs. The Tech Base Requirements provided the context for MITRE's revision of the initial FY97 Tech Base assessment and STRICOM's subsequent establishment of investment needs under the Tech Base Program for FY00 and beyond. This report provides the results of these efforts.

3. Approach:

a. Derivation of Tech Base Requirements

Any assessment of the M&S technology areas benefits from the context of user requirements by narrowing its scope to specific user needs. In this case, the principal customers of STRICOM Tech Base Program are the STRICOM Program Managers – Combined Arms Tactical Trainer (PM CATT), Instrumentation, Targets, and Threat Simulators (PM ITTS), Training Devices (PM TRADE), and Warfighter Simulation (PM WARSIM). Following a series of meetings with MITRE technical staff, these PMs provided 25 requirements for the STRICOM Tech Base.

The PM requirements were "de-composed and re-composed" into (ultimately) 39 Tech Base Requirements that provided the context for the technology assessment. During the final phase of this project, the 39 requirements were ranked based on: timing and urgency of investment, importance to a STRICOM "product line;" applicability across PM programs and STRICOM projects; available leverage from other Government research activities; duplicative research in the private sector; and level of risk indicated by preceding (6.1 funded) research.

The Army expresses its future needs through the articulation of future operational capabilities (FOCs), which provide the foundation for the TRADOC requirements determination process. Hence, the STRICOM Tech Base Program is also required to support those FOCs for which STRICOM has some degree of responsibility. These FOCs were identified and reviewed against the Tech Base Requirements.

b. Technology Areas Assessed

Ten senior members of MITRE's technical staff with recent and extensive background in M&S technology areas, including last year's assessment, reviewed the STRICOM Tech Base requirements to identify the specific demands against their respective M&S technology areas. They adjusted the scope of their technology areas including the identification of component or "enabling technologies."

The following technology areas were assessed by the MITRE personnel indicated.

- **Database Management System** – A system providing efficient storage, retrieval, and update for very large data sets. Pertinent subareas include on-line transaction processing, integration of heterogeneous databases, data warehouses and marts, metadata, on-line analysis processing and data mining. By Patricia L. Carbone.
- **Distributed Component Technology** - Enables the development of software components, their deployment, and their execution in a distributed environment via a distributed component platform. By Diane Mularz.
- **Display Technology** – Devices that output real-time quality images of the synthetic environment. Display types assessed include large-area displays, head-mounted displays,

embedded displays, and desktop displays. By Richard Blaha.

- **3D Graphics** – Creation of 3D synthetic scenes for real-time collaboration and interaction. Assessment includes image generation engine, stereoscopic displays, autostereoscopic displays, and holographic displays. By Dr. Harry Veron.
- **3D Sound** – Output spatially placed sound (azimuth and elevation) that correlates real-time to visual objects in the synthetic environment. Assessment includes head-related transfer function (HRTF), digital signal processing (DSP), and wireless headphones. By Richard Blaha.
- **Intelligent Simulations** – Knowledge and modeling technology required to emulate the behavior of manned platforms and human individuals, groups, and organizations in a simulation. Assessment includes modeling sensation and perception, action and reaction, deliberation and cognition, and interaction. By Jeff Opper.
- **Micro- and Nano-Technologies** - Micro-Technologies build devices with parts as small as 0.1 micron based on lithography (light, electrons, X-ray, ions); nanotechnologies build devices from 100 nm down to 0.1 nm in size (or equivalently, from 0.1 micron all the way down to single atoms) with techniques including atomic probes, chemistry, biology, and genetics. By Terry Bollinger and Dr. James Ellenbogen.
- **Networking Technologies**– Technologies that allow synthetic environments (se) to communicate with other synthetic environments including end system processing, high-speed switched networking, and classical IP routing. By Sham Chakravorty.
- **Sensor Processing** – Digital processing of objects, real or synthetic, to produce representations of sensor systems, sensor data, and/or sensor imagery in interactive simulators and constructive simulations. Assessment includes simulation of sensors, simulation of multi-sensor fusion systems, sensor stimulation, neural networks, and digital data compression. By Dr. Ward Evans.
- **Synthetic Natural Environment** - Representation of the physical world within which all models of military systems exist and interact. It includes both data and models representing the elements of the environment and their effects on military systems, and models of the impact of military systems on environmental variables. By Dr. Paul Birkel.
- **Tracking Technologies** – Automated systems that track the position, orientation and movement of the soldier and aiming direction of their weapons. Assessment includes sensor development, computer vision / image understanding, and holographic tracking. By Richard Blaha.
- **Voice Interfaces** – Communication between humans and computers via spoken language. Assessment includes realistic speech synthesis, speaker independent speech recognition, free - form speech input to recognizer, speech recognition in noise, and recognition of speech under stress. By Dr. Margot Peet.

c. Metrics.

Again using the Tech Base Requirements for context, metrics were identified for the technologies to be assessed. In general, the metrics are objective (but sometimes subjective) measures of the fitness of a technology to support a requirement -- will it do what is required, how well, at what cost, etc. However, most of the Tech Base Requirements require additional detail to establish actual threshold and objective values for the metrics. Where appropriate, common performance measures used by industry (generic, independent of requirements) are provided in the assessments.

d. Technology Assessment

The technology assessments address current capabilities and market trends, and then offer a prognosis for the near (2000), mid (2004), and far (2008) terms. They are based on the author's current experiences in Government-sponsored R&D, commercial research, and observations on the open market.

Additionally, recommendations for STRICOM investment and leverage of related Government programs were developed for each enabling technology. In general, technologies with strong, commercial markets were not considered suitable for relatively small DOD investment. In these cases, STRICOM must monitor and accommodate its requirements to the trends of the commercial market. On the other hand, promising "niche" technologies, with markets limited to DOD, are recommended for STRICOM investment. Recommendations for leveraging other Government research efforts are based on the author's immediate knowledge and should not be considered as exclusive.

The assessments were presented by MITRE to STRICOM in a series of presentations during July-August 1998.

e. Investment Planning

Coincident to the technology assessments, MITRE's Economic Analysis and Decision Center (EDAC) initiated independent research on investment planning required by DOD activities falling under the Information Technologies Management Reform Act (ITMRA). STRICOM agreed to act as a test case for this research, receiving an investment planning process tailored for the Tech Base Program as a quid pro quo.

The STRICOM Tech Base investment planning process must be repeatable, consistent, and result in investments relevant to STRICOM technology needs. The investment planning process must include a traceable integration of tech base requirements from STRICOM PM requirements, objective assessments of enabling technologies based on metrics derived from the PM requirements, a prioritization of identified deficiencies, and multiple forms of investments to leverage the greatest return.

The methodology used is the commercial Balanced Scorecard (BSC) approach customized to STRICOM's environment, including its mission and budgetary profile. It builds on the requirement analysis and the technology assessment described elsewhere in this report. Following MITRE's presentation of the technology assessments to STRICOM, MITRE and STRICOM personnel from the Engineering Directorate followed a step-by-step process to generate the STRICOM BSC able to support the formulation of an investment strategy:

Step 1. Prioritize STRICOM's Tech Base Requirements by balancing them across the following perspectives:

- Relative importance attached to a requirement by the STRICOM PMs
- Urgency of the requirement to PM programs
- Requirement scope
- Value across the STRICOM enterprise

Step 2. Validate the technology areas purported to support STRICOM's Tech Base Requirements

Step 3. Determine relative importance of technology areas to individual Tech Base Requirements

Step 4. Determine relative importance of technology areas across all Tech Base Requirements by balancing them across:

- Current technology gaps
- Urgency of investment
- Applicability across multiple projects and PMs
- Ability to leverage other capabilities
- STRICOM-unique technology
- Risk

The STRICOM Tech Base BSC was generated during a series of working sessions of MITRE and STRICOM's Technical Council during 26-28 August 1998.

1. **Future Work**

   The Tech Base Assessment and BSC process assisted in the identification of technology investment candidates, using a systematic and repeatable process. However, an investment strategy requires additional insight into the costs associated with each investment option and an analysis of the appropriate contractual vehicle(s). Accordingly, the next step is to advertise the prioritized technology requirement and solicit proposals for work in the technology areas. Proposals in response to STRICOM advertisements would be significantly enhanced if the advertisements identified threshold and objective values of the metrics associated with the Tech Base Requirements. On receipt of such proposals, further work can be done to conduct a thorough cost-benefit analysis.
2. **Point of Contact.** The STRICOM Technology Base POC is Robert A. Sottilare, (407)-384-3655, robert_sottilare@stricom.army.mil

The MITRE project lead for this effort is Hugh A. Kelley, (407) 208-1320, hkelley@mitre.org.